Abstract
The acoustical properties of surfaces are essential to understand and optimize the sound field in enclosures; thus they have been the subject of extensive research. Two properties are typically studied, namely the absorption and the scattering of sound. Nevertheless, the interaction between a sound field and a surface is a complex phenomenon, which is often simplified for ease of use, e.g. for room acoustics modeling and material specifications. Moreover, the traditional experimental techniques to characterize surfaces occur in laboratories and assume specific sound field conditions. As a result, the understanding of surface properties remains limited.

This PhD project introduces approaches to evaluate the properties of surfaces based on sound field measurements. The proposed approaches make use of sensing methods to measure spatial and temporal properties of the sound field near the surface. More specifically, absorption is characterized by an angle-dependent surface impedance, which can be obtained from the knowledge of the sound field on the studied surface. In this work, a measurement technique is presented, where microphone array measurements and an equivalent source method are used to reconstruct the sound field on the surface. Some essential aspects of the method are examined, such as the array geometry and the finiteness of the sample under test. As for scattering, it is formulated as a wave disturbance problem, where the effect of a given sample is described with a complex directivity function, called the far-field pattern. This function is uniquely defined by the sample and it contains extensive information, including not only surface scattering but also absorption and finite-size effects. A method is presented to estimate the far-field pattern from near-field measurements of both sound pressure and particle velocity around the sample, based on a discretized Helmholtz Integral Equation (HIE). It is also shown that surface properties can be extracted from the far-field pattern, by manipulating the HIE. Both impedance and far-field pattern estimations were validated through numerical simulations and experimental tests in anechoic conditions. The chosen measures are particularly informative, as they include phase information and angle dependence.

The established methods make it possible to fully characterize acoustic samples such as absorbers and diffusers, which can be beneficial for designing and modeling such elements. The proposed measurement techniques also constitute applications
for microphone arrays and sound intensity probes.